

likewise be admitted for the beings lowest in the scale. But then, we may add, on the supposition that the scale rests on pure matter, it is not on the lowest grade that we find the infinitely minute creatures, but already some way up, so much so that the gap separating them from the bottom is infinitely greater than that which they would have to traverse to arrive at the summit."

In conclusion, it may be said that everyone interested in the study of microscopic forms of life will welcome this work from the hand of an enthusiastic observer, who has a most intimate knowledge at first hand with the creatures about which he is writing, and who has achieved a wide reputation as an investigator of the fresh-water Protozoa. The work is weakest on the side which deals with the minuter phenomena of the cell and nucleus, especially in relation to reproduction, the study of which during the last decade has developed with such rapidity and has brought forth results of such fundamental importance in biology. The author is evidently more of a naturalist than of a cytologist, but it is perhaps too much to expect detailed cytological work in a systematic monograph even of a group of Protozoa. As a general survey of the peculiar forms dealt with it will be found most useful, not only as an exposition of the present state of knowledge, but even more as indicating how much still remains to be worked out with regard to the affinities of the Heliozoa and allied forms of life. By directing attention to the many interesting problems these lowly creatures present for solution, it may be hoped that this monograph will act as a guide and stimulus to investigators in all countries.

E. A. M.

TREES.

Trees. By Prof. H. Marshall Ward. Vol. i. Buds and Twigs. Pp. xiv+271. Vol. ii. Leaves. Pp. x+348. (Cambridge: University Press, 1904.) Price 4s. 6d. net each.

AS one might naturally expect from the scant attention which has hitherto been given to the study of forestry in this country, our literature on the subject is by no means what it ought to be. True, we have several standard works, excellent of their kind, which, however, deal with trees more from a sylvicultural than from a botanical aspect. Students of forestry, and especially students of forest botany, and all those interested in the growth and cultivation of trees, have long felt the great want of a suitable text-book or guide to their studies, but happily now, with the appearance of the above handbook from the facile pen of Prof. Marshall Ward, this want has become a thing of the past.

The work will consist of several parts—each part forming a volume—the first of which is already to hand, and treats of buds and twigs. The mere mention of buds and twigs might suggest to some a dry, uninteresting study of minute details; but never was a greater mistake made than to imagine such is the case. The study of our trees and shrubs in their winter condition has a fascination all its own, and, in addition to this, the clear and simple way in which

the author treats the subject is sure to inspire many with interest and enthusiasm for the study of forest botany.

The study of the minute structure of plants in the laboratory has in many cases received the lion's share of attention, with the result that students have been taught to know the internal structure of plants before they were able to recognise these plants in the field. The author clearly recognises this fact, and plainly states that his object is to bring the student more into touch with the plant in its natural surroundings, where he may form a personal acquaintance with it and learn to observe and note facts for himself, and thereby lay a solid foundation for the further study of the biology of the living plant of whatever kind or nature. The opening chapter gives a short but clear account of the general segmentation of the plant. The next eight chapters are devoted to a consideration of buds. The different kinds, structure, position, arrangement, and function are described in a most masterly and interesting fashion. The next seven chapters deal with the different kinds of shoots—their tegumentary systems, leaf-casting and the formation of leaf scars, lenticels, twigs and other accessory characters.

The second portion of the book contains a very comprehensive classification of trees and shrubs according to characters afforded by their buds and twigs. The classification is accompanied by a complete set of illustrations, showing very clearly in pictorial form all those features by which the species may be determined in their winter condition. Most of those drawings have been done by Miss Dawson, of the County School, Cambridge, to whose artistic skill they do great credit. The other illustrations with which the volume teems have been obtained from various sources, and are all duly acknowledged by the author.

The work will be found indispensable to those students who wish to make an expert study of forest botany. At the same time it is expressed in language so clear and devoid of technicalities that the amateur who wishes to know something about our trees and shrubs will find this one of the most useful guides to which he can turn.

Succeeding volumes will deal with leaves, inflorescences and flowers, fruits and seeds, seedlings, and the habit and conformation of the tree as a whole, and each of those volumes, like the present one, will contain diagnostic tables at the end, devised for use in the field.

From the foregoing it will be seen that the work is a many-sided one, acting not only as a guide to the naturalist in the field, but also as a laboratory handbook, where the use of the lens and microscope may be employed to amplify the study of objects already observed in their natural habitats.

Botanists generally, and especially forest botanists, will welcome the appearance of this book as supplying a decided want, and filling a distinct gap in our literature of forest botany.

Since the above was written the second volume has appeared. As already stated, it deals with leaves, and, like vol. i., consists of a general and a special part.

The general part contains an admirable and exhaustive treatment of the external features of leaves,

their form, composition and arrangement, together with the general characters of their venation, surface and texture; nor has the author omitted to go into the more detailed but equally important consideration of the anatomical structure and physiological functions of leaves. This part also contains many lists comprising those leaves which show the same common features as regards arrangement on the twig, form of venation, character of base, apex and margin of lamina, &c.

Part ii. of this volume, like that of vol. i., gives the classification of trees and shrubs, but, in this case, according to the character of their leaves. A useful glossary is given at the end of the volume, so that the beginner need have no difficulty in understanding the few but necessary technical terms which are used in the book.

ADVANCES IN PHYSICAL SCIENCE.

The Recent Development of Physical Science. By W. C. D. Whetham, F.R.S. Pp. xii+344. (London: John Murray, 1904.) Price 7s. 6d. net.

IT is now nearly thirty years since Prof. Tait published his lectures on "Recent Advances in Physical Science." The period that has since elapsed has been one of remarkable fruitfulness, and it is a suggestive fact that the fundamental problems of physical science which were dealt with by Prof. Tait have to so large an extent supplied the motive for the investigations now described by Mr. Whetham. Foremost amongst these perennial problems must be placed the structure of matter, the mutation of energy, and the nature of comets and nebulae. Lord Kelvin's vortex-ring theory of the atom, so lucidly expounded by Prof. Tait, finds in the later volume its analogue in the electrical or corpuscular atom of Prof. J. J. Thomson, and the doctrine of the conservation of energy, which occupies the foremost position in the earlier volume, is again brought into prominence by the recent suggestions that the internal motion of the atom, be it that of a vortex ring or of a moving electron, may perhaps be drawn upon to supply the energy that is liberated from some hidden storehouse by the radio-active elements.

After an introductory chapter on the philosophical basis of the science, Mr. Whetham devotes two chapters to the liquefaction of gases and the phenomena of fusion and solidification. These two chapters afford striking examples of the way in which recent years have added to the equipment of the experimental sciences, not only by increasing the range of temperatures within which investigations may now be conducted, but also by providing the means of accurately measuring these temperatures. Under the heading of "Fusion and Solidification" Mr. Whetham has given a concise and readable account of the knowledge recently acquired with reference to the structure of metals and alloys. The examples, already classical, of the copper-tin alloys studied by Roberts-Austen and by Heycock and Neville, and the iron-carbon alloys studied by Osmond, le Chatelier, Roberts-Austen, and others are described. Photomicrographs of the former

series of alloys are given. The most fascinating part of the chapter, however, is that which deals with Mr. Beilby's recent investigations of the surface structure of solids. These investigations have shown that even a brittle metal like antimony can be made at ordinary temperatures to flow like a liquid, so that when it is rubbed with fine emery paper the surface produced is not jagged or crystalline, but under the highest magnification appears rather like a freshly painted surface on which the rounded streaks left by the brush are still visible.

In the chapter on the problems of solution, the mechanism of electrolysis is discussed from the point of view of Arrhenius's theory of electrolytic dissociation, but the arguments in favour of this theory are stated with a moderation that is in marked contrast to the one-sided statements that have sometimes been put forward by ardent supporters of the theory. In considering the nature of colloidal solutions, a purely physical explanation is given of the coagulation of the proteids; the observation that "the direction of movement of certain proteids" under the influence of an electric current "could be changed by changing the solvent from a very dilute acid to a very dilute alkali" would be interpreted by the chemist as evidence of their power, as amino-acids, to function either as acid or as base, whilst the fact that "if the solvent was very carefully neutralised an isoelectric point was reached at which the solution became very unstable and coagulation seemed to occur spontaneously" would be ascribed to the tendency of the free amino-acid to condense and form a more complex molecule in the manner characteristic of this group of compounds.

The chapters on the conduction of electricity through gases and on radio-activity contain a concise account of the series of investigations that have been co-ordinated in the recently published works of Prof. J. J. Thomson and Prof. Rutherford. The chapter on atoms and æther derives its chief interest from the inclusion in it of the results of Prof. Thomson's recent investigations of the stability of a system of negatively charged corpuscles revolving in orbits within a positively charged sphere. The atomic model suggested by such a system gives, probably for the first time, a clear representation of the periodic properties of the elements, including the variation in valency, which is the most characteristic of these properties.

The final chapter, on astrophysics, contains an account of the more recent results of spectroscopic investigations of the sun and stars, and includes reproductions of three of the most striking of Prof. Hale's solar photographs. In the later part of the chapter the pressure due to radiation is considered and applied to the explanation of the curious phenomena of comets' tails, whilst the mutual repulsion of radiating particles is suggested as a possible explanation of the permanence of Saturn's rings.

The author has sought to express the results of recent physical investigations in a form which "might prove useful to students of science in general," and "also appeal to those who, with little definite scientific training, are interested in the more important conclusions of scientific thought." In the former part